AN INTRODUCTION TO FLOW AND TRANSPORT IN FRACTAL MODELS OF POROUS MEDIA: PART II

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Abstract

This is the second part of the special issue on fractal geometry and its applications to the modeling of flow and transport in porous media, in which 10 original research articles and one review article are included. Combining to the first part of 11 original research articles, these two issues summarized current research on fractal models applied to porous media that will help to further advance this multidisciplinary development. This whole special issue is published also to celebrate the 70th birthday of Professor Boming Yu for his distinguished researches on fractal geometry and its application to transport physics of porous media.

Keywords: Flow and Transport; Fractal Model; Porous Media.

1. INTRODUCTION

As shown in the introduction of the first part of this section,[1] the data confirm the great interest and activity from theoretical perspective to engineering applied science for fractal theory and its application. We are grateful to the Editors of FRACTALS, especially for Ms. Joy Quek, for providing the opportunity to compile this forthcoming special issue on recent original researches and several novel theoretical development on fractal theory and fractal modeling of flow and transport in porous media.

This special issue is presented also to celebrate the 70th birthday of Professor Boming Yu for his distinguished researches on the transport physics of fractal porous media.

2. OVERVIEW OF WORK PRESENTED IN THIS SPECIAL ISSUE

In the second part of the special issue of *Fractals*, 10 original research articles and one review work are accepted for publication.

For the novel theoretical development of fractal geometry, Perfect and Donnelly[2] introduces a new method for discriminating between mass fractal, pore fractal, and Euclidean scaling in images that display apparent two-phase fractal behavior when analyzed using the traditional method. Their new method, coined "bi-phase box counting", involves box-counting the selected phase and its complement, fitting both datasets conjointly to fractal and/or Euclidean scaling relations, and examining the errors from the resulting regression analyses. Wei *et al.*[3] derived a simple relation between fractal dimension of random walker and tortuosity fractal dimension of current streamlines, and proposed a novel method of computing tortuosity fractal dimension for different generations of two-dimensional Sierpinski carpet and three-dimensional Sierpinski sponge model through the finite element method, accordingly, the fractal dimension of random walker can be predicted.

For the application of fractal geometry on porous media, Lu *et al.*[4] analyzed crystal layer structure formation and impurity distribution of melt crystallization, in which fractal dimensions were introduced to analyze the structural property of the porous crystal layer and the melt phase migration behavior. Zhang *et al.*[5] developed and numerically analyzed an unsteady heat transfer model accompanied with solidification phase change in fractal porous metal foam embedded with phase change material based on two-dimensional mass prefractal model. Ghanbarian *et al.*[6] invoked scaling concepts from percolation theory and effective medium theory to predict the saturation dependence of modes of transport in two disturbed soils (hydraulic and electrical conductivity, air permeability, and gas diffusion). Korfanta and Babadagli[7] performed experiments to study the effect of fracture surface roughness on fluid distribution during miscible displacement, in which the surface roughness of each sample was described by fractal dimensions using the variogram, power spectral, and triangular prism techniques. Relationships between the fractal dimensions of displacement fronts and fracture surfaces were quantitatively analyzed and correlated in order to improve the prediction of fluid distribution within a single fracture during miscible displacement. Cámara *et al.*[8] researched the relationship between the hierarchical structure of the drainage networks at hillslope scale and the heterogeneity of the particle-size distribution at pedon scale. In their work, the fractal dimension was selected to measure the hierarchical structure of the drainage networks, while the Balanced Entropy Index was the chosen parameter to quantify the heterogeneity of the particle-size distribution from textural data. For the formation damage evaluation of reservoirs, You *et al.*[9] presented fractal analysis derived from Scanning Electron Microscopy image of shale pore structure to quantify the shale formation damage. Paredes *et al.*[10] introduced fractal and other techniques to identify self-organized critical features in the distribution and pattern to a particular case: the Holderness shoreline. Xiao *et al.*[11] applied fractal theory to study gas diffusivity of porous nanofibers, and obtained analytical gas diffusivity model, which was verified by experimental data.

For the overview on the recent fractal works, Cai *et al.*[12] reviewed the recent works on the permeability of fibrous porous media by means of fractal geometry, analyzed the advances for each presented fractal model and parameter equations used in available fractal permeability models. Future work for more generalized permeability model of fibrous porous media were commented.

3. SUMMARY REMARKS AND SHORT BIOGRAPHY FOR PROFESSOR BOMING YU

This special issue presents some basic, applied, and review articles on the recent developments and research efforts in the field of fractal modeling of fluid flow and transport properties of porous media, with the purpose of improving our understanding of the mechanisms of flow and transport in complex porous systems and providing guidelines for future research in this area.

Professor Boming Yu graduated in Engineering Physics at Tsinghua University (Beijing, China) in 1970, and graduated in Nuclear Engineering at Tsinghua University (Beijing, China) in 1981 and received Masters degree there. He began his academic career at the Wuhan Steel and Iron Institute (Wuhan, China) in 1983. In 1986, he joined the Huazhong University of Science and Technology (Wuhan, China), where he was promoted to Full Professor in 1996. From 1996–1999, Prof. Yu was invited to do the Visiting work at the Ohio State University, USA, and in the summers of 2000 and 2005 Prof. Yu was invited to do the collaborated research work at the Hong Kong University of Science and Technology and National University of Singapore. Prof. Yu was also invited to visit the Institute of Physics, Academic Sinica, Taipei in 2006 and 2008.

Professor Yu's research interests cover a wide range of topics such as Fractals, Transport in Fractal Porous Media, Nanofluids, Boiling Heat Transfer, and Complex networks (interesting readers may consult his review paper[13]). So far, he has published more than 150 peer reviewed journal papers and among them more than 100 journal papers are involved in the area of transport in fractal porous media, and he and his coworkers have recently published one Book entitled "Transport Physics in Fractal Porous Media" (in Chinese). In the past years, Prof. Yu was invited to give talks at several international conferences. Prof. Yu's contribution to the area of transport in fractal porous media is impressive. Prof. Yu also serves as Managing Editor (for Asian-Pacific) for Fractals and as Editors for several other journals.

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